

DOCUMENT RESUME

ED 176 947

SE 027 846

AUTHOR Steel, Lauri; And Others
 TITLE Origins of Sex Differences in High School Mathematics Achievement and Participation.
 INSTITUTION American Institutes for Research in the Behavioral Sciences, Palo Alto, Calif.
 SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
 PUB DATE [78]
 GRANT NIE-G-78-0001
 NOTE 28p.

EDRS PRICE MF01/PC02 Plus Postage.
 DESCRIPTORS *Achievement; Career Choice; *Curriculum; *Educational Research; Instruction; Interests; *Mathematics Education; Secondary Education; *Secondary School Mathematics; *Sex Differences

ABSTRACT

The goal of this study was to identify the origins of observed sex differences in high school mathematics achievement. At the beginning of high school, boys and girls did not differ significantly in their levels of mathematics achievement, but by twelfth grade the boys had gained over twice as much as the girls. The findings from this study reveal that virtually all the sex differences in mathematics achievement can be explained by sex differences in participation in high school mathematics. The number of mathematics courses taken during high school was predicted most strongly by mathematics achievement and educational expectations in ninth grade, both measures on which only minimal sex differences were found. Among students of equal ability and educational aspirations, sex differences in mathematics participation appeared to be due to differences in interests in mathematics and in mathematics-related careers. (MP)

 * Reproductions supplied by EDRS are the best that can be made *
 * from the original document. *

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY

Markita Gulliver

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."

ORIGINS OF SEX DIFFERENCES IN HIGH SCHOOL
MATHEMATICS ACHIEVEMENT AND PARTICIPATION

Lauri Steel
Lauress Wise
Markita Gulliver

American Institutes for Research

P.O. Box 1113

Palo Alto, CA 94302

The research reported here was carried out with funds provided through grant NIE-G-78-0001 from the National Institute of Education. The content does not necessarily reflect the position or policy of the National Institute of Education, and no official endorsement should be inferred.

ORIGINS OF SEX DIFFERENCES IN HIGH SCHOOL MATHEMATICS ACHIEVEMENT AND PARTICIPATION

A number of previous studies have found sex differences in mathematics achievement, which tend to occur by junior high school and increase during high school. A variety of explanations of possible determinants have been suggested for such sex-related differences. These factors can be categorized as biological-genetic, spatial aptitude, sex-stereotyping or attitudinal. (See Sherman, 1977, for extensive review of these factors.) The present study did not address biological-genetic or spatial aptitude factors. Numerous studies have also investigated sex-stereotyping and attitudinal factors (Fox, 1976, Haven, 1972, Hilton and Berglund, 1974, Fennema, 1976). Factors which have been identified as possible determinants of differential levels of achievement include sex differences in participation in high school mathematics courses, sex differences in career interests and aspirations and sex differences in attitudes toward mathematics. The present study assessed the relative contribution of these and other factors to the observed sex differences in high school mathematics achievement. The specific objectives were

1. to determine the nature and extent of sex differences in math achievement during high school;
2. to determine the extent to which these differences could be explained by sex differences in participation in math courses during high school; and
3. to determine the extent to which, and the ways in which, specific background, cognitive, social-psychological, or environmental factors contribute to sex differences in participation in high school mathematics and to sex differences in math achievement in high school.

DESIGN

Data from the Project TALENT data base was used to investigate these research issues. A complete report of the procedures used to select the original sample of TALENT participants are described in detail in The Project TALENT Data Bank Handbook (Wise, McLaughlin, Steel, 1977). The TALENT data base contains extensive information on the backgrounds, abilities, interests, plans, and activities of a nationally representative sample of approximately 400,000 students in grades 9-12 in 1960, as well as data on their subsequent educational, career, and personal experiences over the next 15 years. Data was also collected in 1960 on the characteristics of the schools these students attended.

A subgroup of approximately 7500 of the TALENT 9th grade cohort was retested as 12th grade students in 1963. The same instruments used in 1960 were administered in this retest, although because of time constraints each student could only be given approximately half of the test battery. Six different but overlapping combinations of the tests and questionnaires were administered in the retest, so that each instrument was completed by approximately half the students. Approximately 1100 of the students in the retest sample completed the 1960 Student Information Blank, the math achievement and information tests, and the interest inventory--the instruments of primary interest for this study. Most of the analyses were based on this group of 1100.

Study Variables

The large amount of data derived from the sources described above were categorized into six groups of factors which theoretically might affect 12th grade math achievement. These groups of variables are shown in the conceptual framework of the study. (Figure 1) The following variables were of particular importance to the results reported here.

Math Achievement. The math achievement measure used in this study was a 54-item test including 16 "word problem" items designed to measure arithmetic reasoning, 24 introductory math items primarily covering elementary algebra and number theory, and 14 advanced math items covering topics generally taught in grades 10 through 12 including plane geometry, analytic geometry, trigonometry, and elementary calculus.

Math Participation. The measure used was the number of semesters of high school mathematics reported in the 1960 Student Information Blank.

Math Level of Careers. This variable (ranging from 1 to 6) was determined by the amount of mathematics required by a particular career. Level 6 requires graduate level mathematics (e.g. mathematician); level 5 requires some advanced college mathematics (e.g. engineer, physicist) and level 4 requires some college math (biologist, pharmacist, physician). These three levels were grouped as math-related careers since all require at least some college level mathematics. Level 3 requires college preparation and possibly statistics, but not calculus. An example career might be lawyer, accountant or sociologist. Level 2 requires high school mathematics (e.g. nurse, police, fire, sales) while level 1 requires little or no mathematics (barber/beautician, unskilled worker). These last two

levels are categorized as non-math-related careers. Students indicated interest in careers on the 1960 Student Information Blank.

RESULTS

Extent of Sex Differences in High School Math Achievement

Figure 2 illustrates the extent of sex differences in math achievement for grades 9 through 12. As can be seen, only slight differences were found among the 9th grade males and females. By 12th grade, however, these differences had become very significant, with mean scores of the males averaging one-third of a standard deviation higher than the scores of the females. It is also apparent from this figure that sex differences begin to be most pronounced in 10th grade when, perhaps not coincidentally, high school math courses become truly elective.

Figure 2 was based on cross-sectional data from the four TALENT cohorts for each grade. Figure 3 illustrates the extent of change in math achievement between grades 9 and 12 for the same individuals. As can be seen, the patterns of achievement gains for males and females are quite similar when these longitudinal data are used.

Extent to Which Sex Differences in High School Math Achievement Are Related to Differences in Participation in High School Math Courses

The two strongest predictors of 12th grade math achievement were 9th grade math achievement ($r = .78$) and the amount of math taken in high school ($r = .73$). To assess the extent to which the sex differences in math participation explained differences in 12th grade math achievement, a two-way ANOVA with sex and amount of math taken as the independent factors was performed (see Table 1). The sex differences were virtually nonexistent after controlling for amount of math taken. There is, however, a small interaction effect with women scoring higher at moderate levels of math participation and men scoring higher at the extremes (see Figure 4).

Table 2 shows the results of another two-way analysis of variance (sex by math taken) where 9th grade math achievement is controlled as a covariate. As can be seen, females with math participation and ability equal to males had scores averaging .1 standard deviation lower than the male scores. While this difference is statistically significant, it is not large. Math taken and 9th grade achievement can account for 71.1% of the variation in 12th grade achievement. Sex can account for 1.6% of the variation in 12th grade achievement when other factors are not controlled, but only .2% after controls are introduced. Thus, roughly

seven-eighths of the relationship between sex and 12th grade math achievement can be attributed to math taken and initial math achievement.

Other Factors Influencing Math Participation and Achievement

Several exploratory regression analyses were performed on other background, 9th grade characteristics, and school environment variables to identify additional predictors of math participation and achievement. Tables 3 and 4 indicate the relative contribution of various individual characteristics to sex differences in math participation and achievement respectively.

With regard to participation in high school mathematics (Table 3), expected level of education, intention to take a college-preparatory curriculum (closely related to educational expectations), interest in math itself, and interest in math-related careers versus interest in office work were found to be predictive of math participation above and beyond the influence of 9th grade math achievement. Sex differences in the interest variables account for most of the sex differences in participation.

Regarding math achievement (Table 4), differences in amount of math taken are by far the most significant component of achievement differences. Interests in math and math-related careers relative to interest in office work also play a very significant role. Participation in extracurricular activities also played a modest role in influencing sex differences in math achievement.

To assess the impact of school characteristics on math achievement, data were aggregated at the school level and "expected" math participation levels and achievement scores were determined for each student based on the variables shown in Tables 3 and 4. "Unexpected" gains (the difference between expected and actual levels of participation and achievement) were then computed and averaged across all students in each school. The mean unexpected gains (or losses) were then correlated with various characteristics of the school environment. The results of these analyses are shown in Tables 5 and 6.

A number of key school characteristics were found to be significantly correlated with 12th grade math achievement and participation levels, but not with unexpected gains in these scores. Only two variables predicted "unexpected" achievement gains: percent of daily absenteeism and current school tax per \$1,000. One additional variable--whether there was an accelerated science curriculum--predicted unexpected gain for females but not for males. Regarding math participation, only one variable predicted "unexpected" participation levels, variety of school facilities, and greater numbers of facilities were related to lower levels of

participation. Proportion of parents in the PTA and frequency of standardized testing predicted unexpectedly high participation levels for women, but not for men.

Summary Model of the Relationship of Sex to High School Mathematics Achievement

To determine the process by which sex and other independent variables relate to high school mathematics participation and achievement, structural models incorporating those variables found to have the strongest relationships to participation and achievement were developed and tested using the LISREL IV programs. Figure 5 shows the model that best summarized the data.

As can be seen, the primary effects of sex on math achievement were through high school math participation. The relationship between sex and math participation is somewhat more complex, with the sex effect being primarily attributable to women's lesser interest in math ($b = -.23$), interest in math-related careers ($b = -.65$), and to the lower math level of women's planned careers ($b = -.24$). The combined indirect effect of sex through the moderator variables shown was $b = -.13$, which exceeds the direct effect of sex ($b = -.09$).

While the other independent variables (e.g., SES, general academic aptitude, school characteristics) also influenced math participation and achievement, they did not add to our understanding of sex differences in these variables. The negative coefficients between math participation and both per-pupil expenditures and proportion of student body planning to attend college are, on the surface, somewhat surprising. However, it is possible that schools with lower per-pupil expenditures or that have lower proportions of their students going on to college present less competitive environments. As a result, students in those schools may be more likely to take higher-level math courses than students of equal ability in more competitive schools.

SUMMARY AND CONCLUSIONS

The goal of this study was to identify the origins of observed sex differences in high school mathematics achievement. At the beginning of high school, boys and girls did not differ significantly in their levels of math achievement, but by 12th grade the boys had gained over twice as much as the girls. The findings from this study reveal that virtually all the sex differences in math achievement can be almost entirely explained by sex differences in participation in high school mathematics.

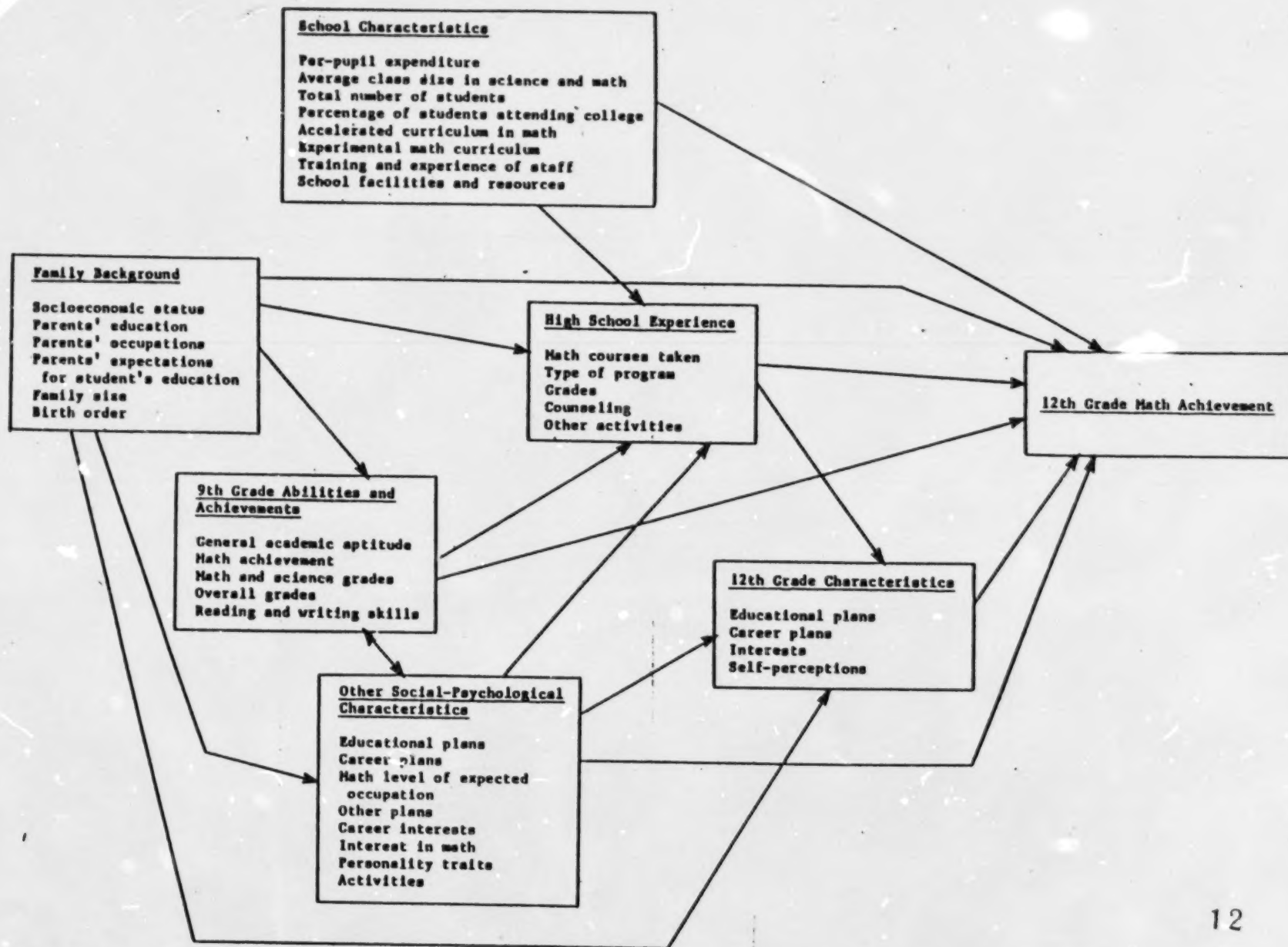
The number of mathematics courses taken during high school was predicted most strongly by mathematics achievement and educational expectations in 9th grade, both measures on which only minimal sex differences were found. Among students of equal ability and educational aspirations, sex differences in math participations appeared to be due to differences in interest in mathematics and in math-related careers. These sex differences in interests and career plans were already evident by the 9th grade.

The findings of the study indicate that efforts to redress the sex differences in math achievement should focus on the processes by which females (and males) develop career-related interest and expectations during elementary and intermediate school. If women are to develop their math abilities to the same extent as men and to maintain their options to pursue science and other math-related careers, it is imperative that factors resulting in sex-typing of career interests and expectations of males and females be identified and eliminated.

BIBLIOGRAPHY

- Aiken, L. R., Jr. Some speculations and findings concerning sex differences in mathematical abilities and attitudes. In Fennema, E. (Ed.), Mathematics Learning: What research says about sex differences, December, 1975. Columbus, Ohio: ERIC Mathematics, Science and Environmental Education Clearinghouse, 13-20.
- Aiken, L. R. Update on attitudes and other affective variables in learning mathematics. Review of Educational Research, 1976, 46 (2), 293-311.
- Fennema, E. Influences of selected cognitive, affective and educational variables (on sex-related differences) in mathematics learning and studying. Madison, Wisconsin: University of Wisconsin, 1976.
- Fennema, E. and Sherman, J. Sexual stereotyping and mathematics learning. The Arithmetic Teacher, 1977a, 24 (5), 369-372.
- Fennema, E., and Sherman, J. Sex-related differences in mathematics achievement, spatial visualization and affective factors. American Educational Research Journal, Winter 1977b, 14 (1), 51-71.
- Fox, L. H. The effects of sex role socialization on mathematics participation and achievement. Baltimore: The Johns Hopkins University, 1976.
- Haven, Z. W. Factors associated with the selection of advanced mathematics courses by girls in high school. Research Bulletin 72-12. Princeton, New Jersey: Educational Testing Service, 1972.
- Hilton, T. L., & Berglund, G. W. Sex differences in mathematics achievement - A longitudinal study. The Journal of Educational Research, 1974, 67, 231-237.
- Kaminski, D. M., Erickson, E. L., Ross, M., and Bradfield, B. Why females don't like mathematics: The effect of parental expectations. Paper presented at the 1976 American Sociological Association Meeting, New York, August 1976.
- Luchins, E. H. Women in mathematics, problems of orientation and reorientation. Final Report. Rensselaer Polytechnic Institute, Troy, N.Y. (Sponsoring Agency, N.S.F. Washington, D.C.) January, 1976.
- Maccoby, E. E. and Jacklin, C. N. Psychology of Sex Differences. Palo Alto, California: Stanford University Press, 1974.
- Sells, L. W. High school mathematics as the critical filter in the job market in developing opportunities for minorities in graduate education. Proceedings of the Conference on Minority Graduate Education at the University of California, Berkeley. May, 1973.
- Sherman, J. Problems of sex differences in space perception and aspects of intellectual functioning. Psychological Review, V. 4, p. 292, 1967. Citing E. M. Sweeney, Sex differences in problem solving, Technical Report No. 1, Stanford University, Stanford, December, 1953.

- Sherman, J. On the psychology of women: A survey of empirical studies. Springfield, Illinois: Charles C. Thomas, 1971.
- Sherman, J. Effects of biological factors on sex-related differences in mathematics achievement. Madison, Wisconsin: Women's Research Institute of Wisconsin, Inc., 1977.
- Sherman, J. and Fennema, E. The study of mathematics by high school girls and boys: Related variables. American Educational Research Journal, Spring 1977, 14 (2), 159-168.
- Stanley, J. C. Accelerating the educational progress of intellectually gifted youths. Educational Psychologist, 1973, 10 (3), 133-146.
- Tobias, S. Math anxiety. Ms., September 1976, 56-59; 80.
- Tobias, S., and Donady, B. Counseling the math anxious. Journal of NAWDAC. Fall, 1977, 13-16.
- U.S. Bureau of the Census. Persons in engineering, scientific and technical occupations, 1970 and 1972. Current Population Reports, No. 45. Washington, D.C.: U.S. Government Printing Office, 1973, p. 23.
- U.S. Bureau of the Census. Statistical Abstracts of the United States. Washington, D.C.: U.S. Government Printing Office, 1975.
- U.S. Department of Labor, Dictionary of Occupational Titles, 1977, Washington, D.C. U. S. Government Printing Office.
- Wittig, M. A. Sex differences in intellectual functioning: How much of a difference do genes make? Sex Roles, 1976, 2, 63-74.
- Wise, L. L., McLaughlin, D. H., and Steel, L. The Project TALENT data bank handbook. Palo Alto, California: American Institutes for Research, 1979.



1 Figure 1. Conceptual framework of study

Mean Mathematics
Achievement in 9th Grade
Standard Score Units

▲ Males
● Females

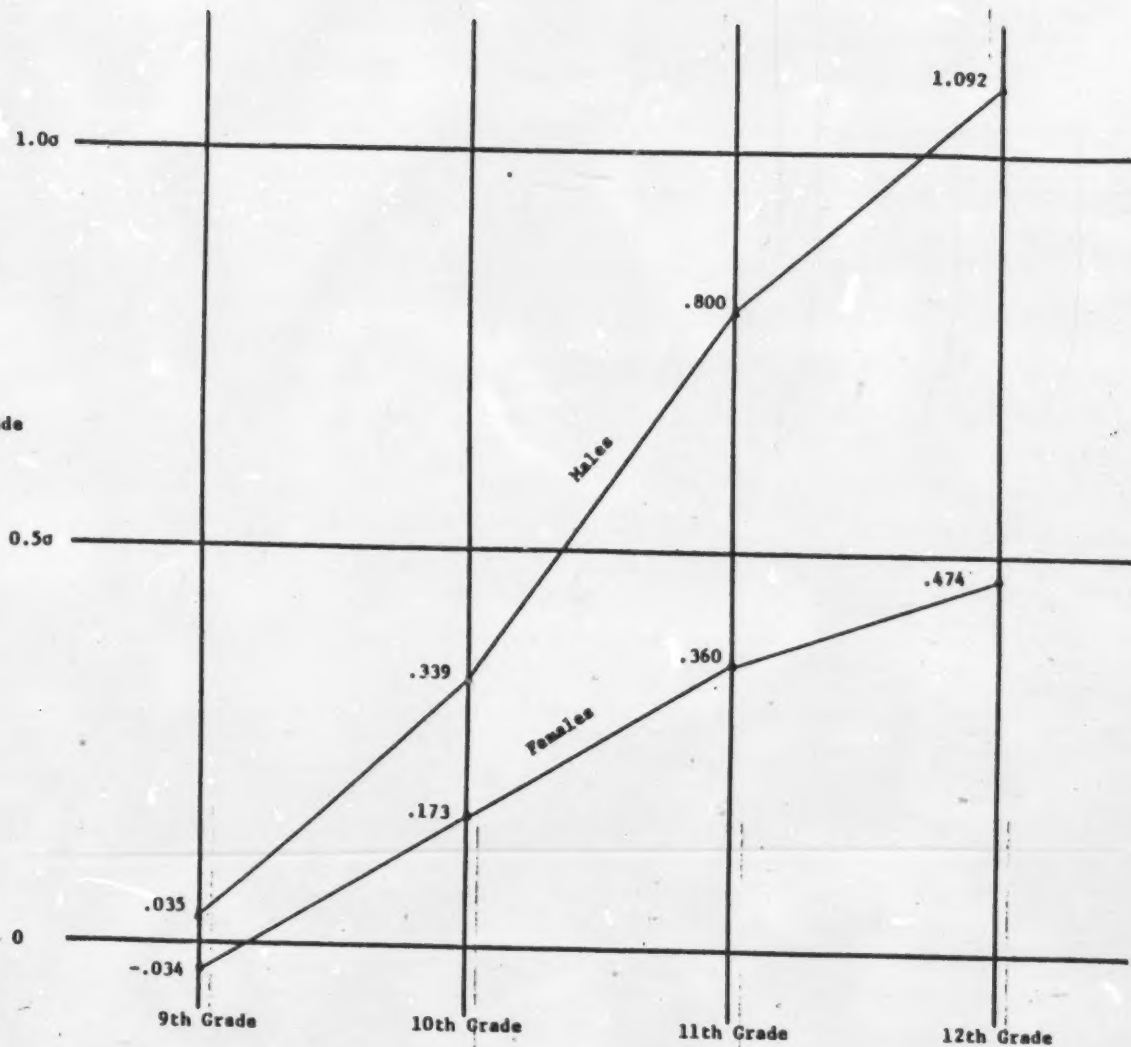


Figure 2. Comparison of Mathematics Achievement Gains of Males and Females

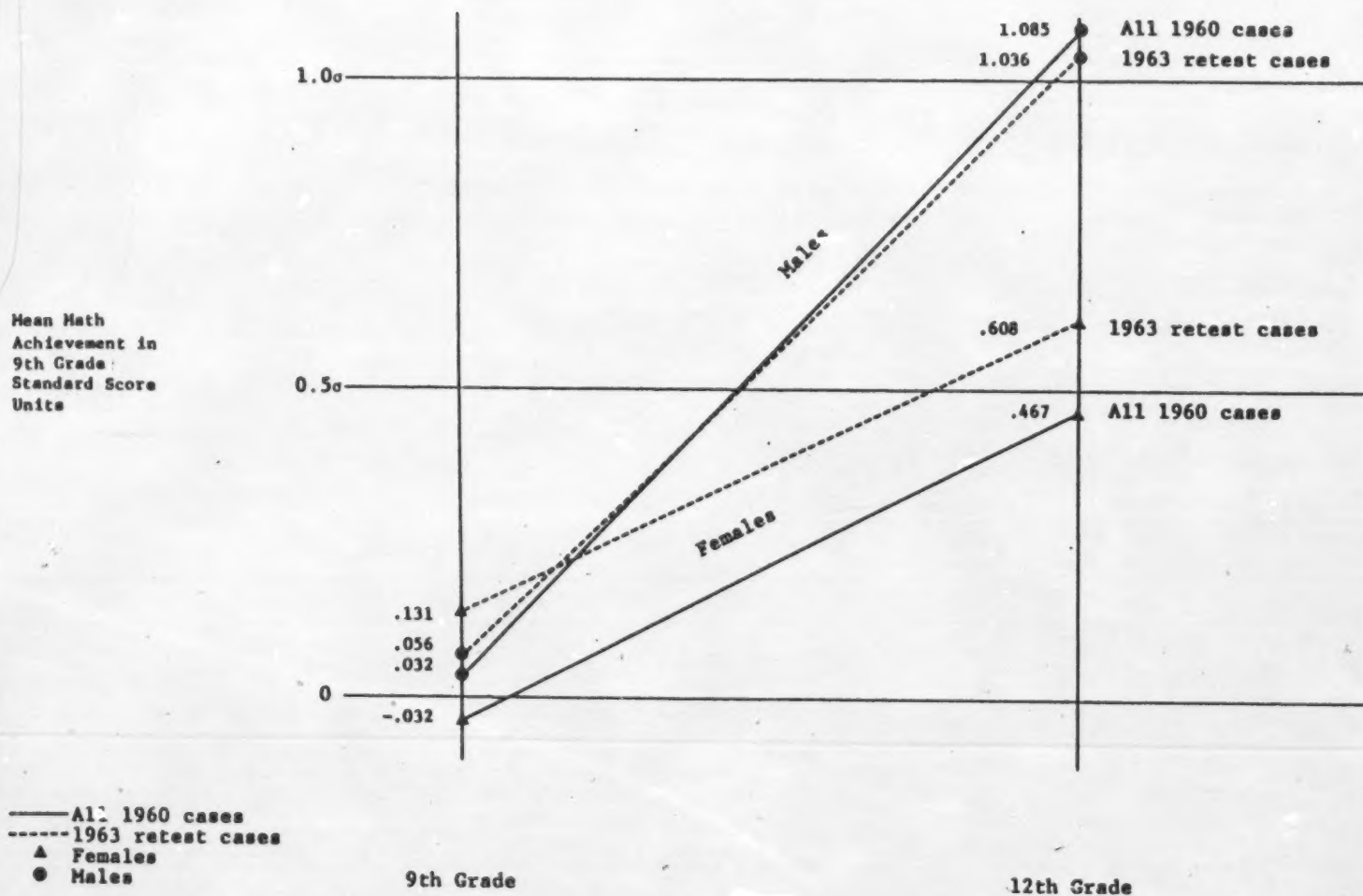


Figure 3. Comparison of the retest sample to the overall 1960 sample in terms of mean math achievement gains

TABLE 1

Two-Way Analysis of Variance of 12th Grade Math Achievement
by Sex and Amount of Math Taken

***** ANALYSIS OF VARIANCE *****
 BNJ40 (12TH GRADE MATH ACHIEVEMENT)
 BY SEX
 MATHTKN (AMOUNT OF MATH TAKEN)

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	65895.750	7	9413.676	202.065	0.001
SEX	1.064	1	1.064	0.023	0.999
MATHTKN	63821.520	6	10636.918	228.322	0.001
2-WAY INTERACTIONS	692.000	6	115.333	2.476	0.022
SEX MATHTKN	692.023	6	115.337	2.476	0.022
EXPLAINED	66587.750	13	5122.133	109.947	0.001
RESIDUAL	53715.312	1153	46.587		
TOTAL	120303.062	1166	103.176		

1210 CASES WERE PROCESSED.
 43 CASES (3.6 PCT) WERE MISSING.

*** MULTIPLE CLASSIFICATION ANALYSIS ***

GRAND MEAN = 27.16

VARIABLE • CATEGORY	N	UNADJUSTED DEV'N	ETA	ADJUSTED FOR INDEPENDENTS DEV'N	BETA	ADJUSTED FOR INDEPENDENTS • COVARIATES DEV'N	BETA
SEX							
1	546	1.42		-0.03			
2	621	-1.25		0.03			
			0.13		0.00		
MATHTKN							
1	178	-9.54		-9.54			
2	222	-6.17		-6.18			
3	228	-2.44		-2.44			
4	229	0.79		0.79			
5	163	9.20		9.21			
6	87	12.12		12.13			
7	60	14.81		14.82			
			0.74		0.74		
MULTIPLE R SQUARED					0.548		
MULTIPLE R					0.740		

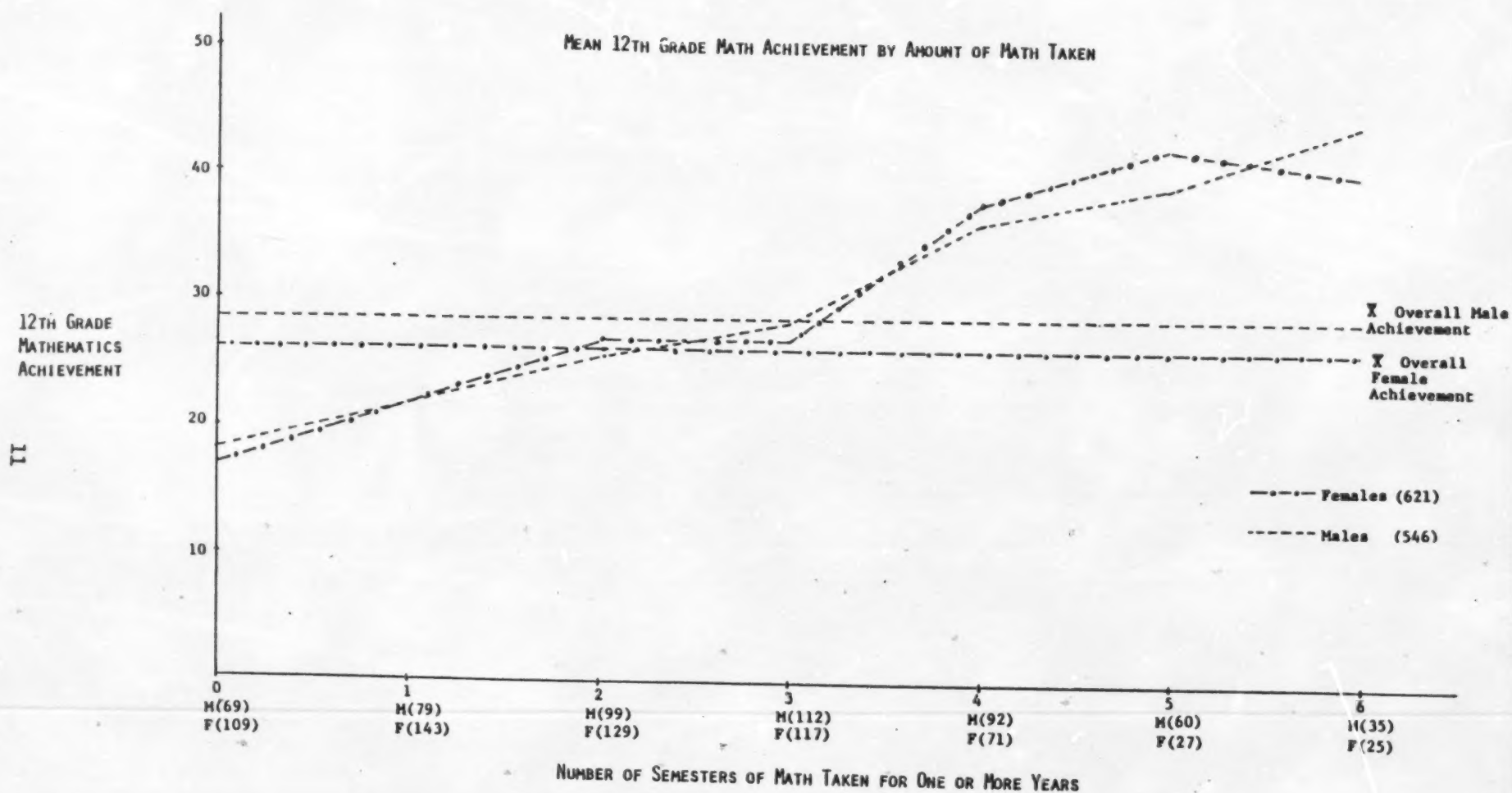


Figure 4. EFFECTS OF MATH PARTICIPATION RATES ON MATH ACHIEVEMENT

TABLE 2

Two-Way Analysis of Covariance of 12th Grade Math Achievement by Sex and
Amount of Math Taken Controlling for 9th Grade Math Achievement

..... ANALYSIS OF VARIANCE
BR340 (12TH GRADE MATH ACHIEVEMENT)
BY SEX
MATHTKN (AMOUNT OF MATH TAKEN)
WITH AMHTOT (9TH GRADE MATH ABILITY)
.....

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
MAIN EFFECTS	83041.375	8	10380.172	350.018	0.001
SEX	271.084	1	271.084	9.141	0.003
MATHTKN	11484.086	6	1914.014	64.540	0.001
AMHTOT (COVAR)	18977.605	1	18977.605	639.922	0.001
2-WAY INTERACTIONS	139.687	6	23.281	0.785	0.999
SEX MATHTKN	139.739	6	23.290	0.785	0.999
EXPLAINED	83181.062	14	5941.504	200.347	0.001
RESIDUAL	33096.250	1116	29.656		
TOTAL	116277.312	1130	102.900		

COVARIATE BETA
AMHTOT 0.546

1210 CASES WERE PROCESSED.
79 CASES (6.5 PCT) WERE MISSING.

*** MULTIPLE CLASSIFICATION ANALYSIS ***

GRAND MEAN = 27.15

VARIABLE + CATEGORY	N	UNADJUSTED DEV'N - ETA	ADJUSTED FOR INDEPENDENTS + COVARIATES DEV'N - BETA	ADJUSTED FOR INDEPENDENTS DEV'N	BETA
SEX					
1	533	1.44		0.53	
2	598	-1.28		-0.47	
		0.13			0.05
MATHTKN					
1	174	-9.43		-4.64	
2	216	-6.21		-3.66	
3	222	-2.30		-1.41	
4	216	0.55		0.17	
5	159	9.29		4.77	
6	84	12.01		7.23	
7	60	14.82		8.49	
		0.74			0.41
MULTIPLE R SQUARED				0.714	
MULTIPLE R				0.845	

TABLE 3

Sex Differences in Math Participation Predicted by Each Variable in the General Regression Equation

<u>Predictor Variable</u>	<u>Mean Sex Difference in Predictor Variable</u>	<u>Regression Coefficient</u>	<u>Predicted Sex Difference</u>	<u>% of Actual Sex Difference</u>
9th Grade Math Achievement	.376	.065	.024	4.0%
Expected Level of Education	.231	.264	.061	10.1%
College Preparatory Curriculum	.048	.475	.023	3.8%
Interest in Math	4.584	.022	.101	16.8%
Interest in Math-Related Careers	9.301	.015	.140	23.3%
Interest in Office Work	-10.217	-.015	.153	25.4%
Total Predicted Sex Difference			.502	83.4%
Actual Sex Difference			.602	
Difference Resulting from Other Factors			.100	16.6%
Multiple Correlation = .73				
Variance Accounted for = 53%				

TABLE 4

Sex Differences in Math Achievement Predicted by Each Variable in the General Regression Equation

<u>Predictor Variable</u>	<u>Mean Sex Difference in Predictor Variable</u>	<u>Regression Coefficient</u>	<u>Predicted Sex Difference</u>	<u>% of Actual Sex Difference</u>
9th Grade Math Achievement	.376	.236	.089	3.5%
Amount of Math Taken	.602	2.041	1.229	47.8%
General 9th Grade Academic Aptitude	-23.303	.032	-.746	-29.0%
Math Level of Expected Occupation	1.574	.371	.584	22.7%
Interest in Math	4.585	.089	.408	15.9%
Interest in Office Work	-10.217	-.058	.593	23.1%
Degree of Extracurricular Activity	-2.144	-.038	.081	3.2%
Total Sex Predicted Difference			2.238	87.2%
Actual Sex Difference			2.569	
Amount Explained by Other Factors			.331	12.8%
Multiple Correlation =	.86			
Variance Accounted for =	74%			

TABLE 5

Correlation of Math Participation Level with General School Characteristics .

	Partial Correlation with Math Participation Level	Partial Correlation with Math Participation Level for Females only	First Order Correlations with Math Participation Level
I. Variables correlated with "expected" math participation levels, but not with "unexpected" levels.			
Honors Courses	0.21	0.21	0.55***
Accelerated Math Curriculum	0.18	0.18	0.35*
Number of Full-time Teachers	0.03	0.04	0.30
Staff Experience/Training	0.04	0.07	0.35*
% Students Enrolled in College Prep Courses	0.18	-0.02	0.53***
% Males and Females Going on to College	-0.09	-0.23	0.48***
Per Pupil Expenditure	-0.10	-0.05	0.40**
% School Support from Local Sources	-0.00	-0.27	0.42**
II. Variables correlated with "unexpected" math participation levels.			
Count of School Facilities Available	-0.27	-0.22	0.03
III. Variables correlated with "unexpected" math participation levels for females.			
% Parents in P.T.A.	0.14	0.27	0.11
Frequency of Standardized Testing	0.22	0.36*	0.19

*significant at the .01 level

**significant at the .005 level

***significant at the .001 level

TABLE 6

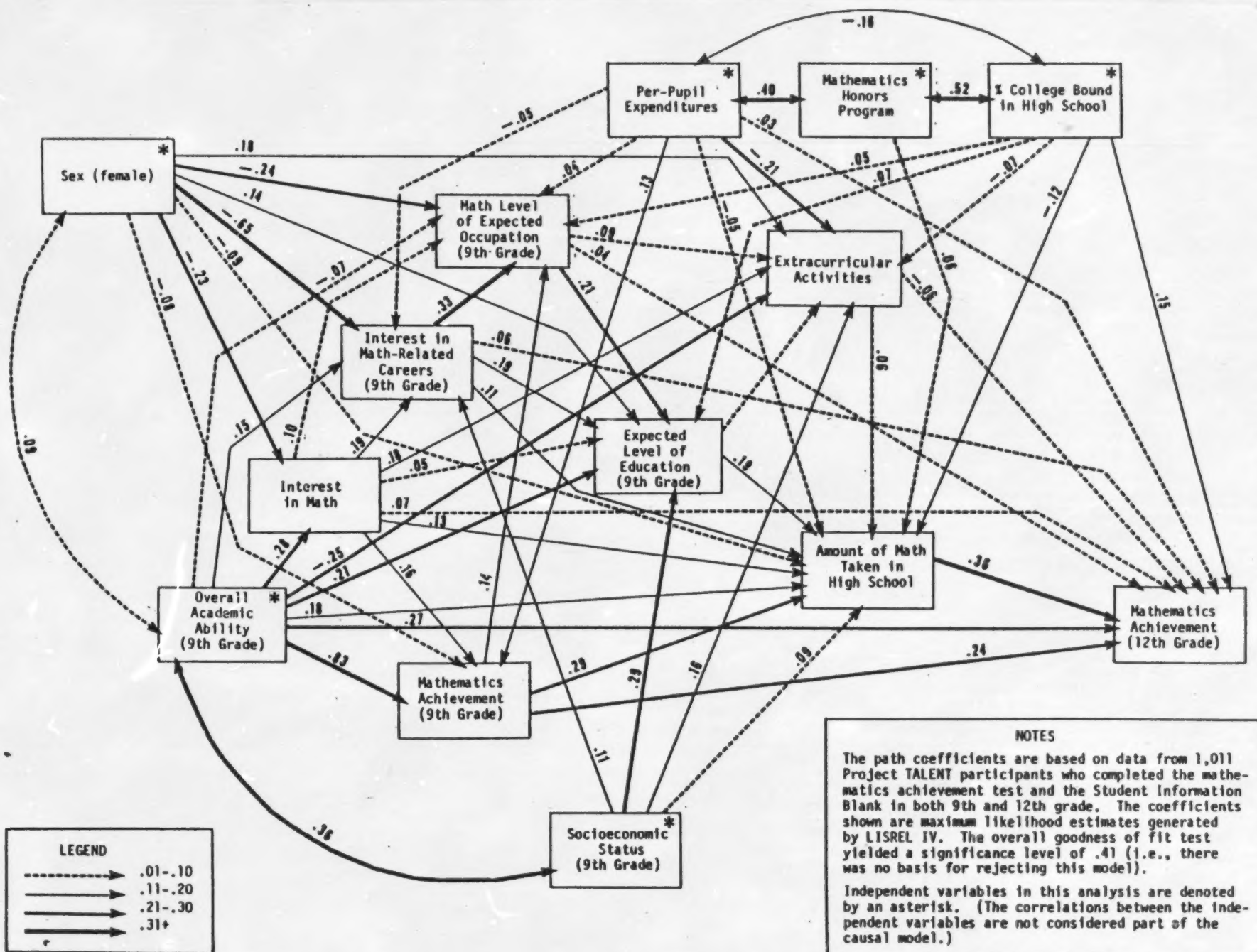
Correlation of 12th Grade Math Achievement Gains with General School Characteristics

	Partial Correlation with 12th Grade Math Achievement	Partial Correlation with 12th Grade Math Achievement for Females only	First Order Correlation with 12th Grade Math Achievement
I. Variables correlated with "expected" 12th grade math achievement gains but not with "unexpected" gains.			
Honors Courses	0.03	0.09	0.48***
Number of Full-time Teachers	-0.03	0.13	0.30
Staff Experience/Training	0.02	0.10	0.40**
% Students Enrolled in College Prep Courses	0.06	-0.01	0.45**
% Males and Females Going on to College	0.08	0.12	0.51***
Expenditure per pupil	0.17	0.14	0.35*
II. Variables correlated with "unexpected" 12th grade math achievement gains.			
% of Daily Absenteeism	-0.29	-0.36*	-0.39**
Current School Tax per \$1000	0.41**	0.26	0.44**
III. Variables correlated with "unexpected" 12th grade math achievement gains for females			
Accelerated Curriculum in Science	0.15	0.32*	0.22

*significant at the .01 level

**significant at the .005 level

***significant at the .001 level



27 Figure 5. Summary path model of the relationship of sex to high school mathematics achievement